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**APPLICATION
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Title: CUSTOMIZED MATTRESS SYSTEM

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SPECIFICATION

CUSTOMIZED MATTRESS SYSTEM

This application claims priority to U.S. provisional patent application serial no. 60/128,104, filed April 7, 1999, hereby expressly incorporated by reference herein.

Field of the Invention

5 This invention relates to the designing or selecting of mattresses and mattress and box spring foundation unit assemblies that are most suitable for persons of various body types, and particularly to the providing of customized mattresses or mattress and box spring assemblies for individual persons.

as B1 **Background of the Invention**

10 Many different mattresses and foundation units are currently available on the market. Each of these may provide acceptable comfort and support for some persons who use them, but all will be less suitable for at least some users. The differences among individual persons with respect to their body frames, physiques and weights and their individual physical characteristics and desires

are large. These differences account for differences in the suitability of particular mattresses or mattress and box spring combinations among members of the public. Presently, there exist systems for determining how pressure may be distributed between the upper supporting surface of a mattress and a person reclining on the mattress. But systems that take into account the support provided by a mattress in maintaining alignment of the spine and other body parts for a particular person or particular type of person are not available.

A need exists for a bedding product providing system that gives users support as well as comfort, particularly a system for correlating the support capabilities of a mattress or mattress system with the support requirements of individual users. There is a particular need for systems for evaluating, designing or selecting particular mattresses or mattress systems for individuals of specific body characteristics and for designing, selecting or customizing such mattresses or mattress systems to meet the support and comfort requirements of such individuals.

Summary of the Invention

An objective of the present invention is to provide specific individuals or persons of specific body types with mattresses or mattress and foundation sets that are particularly suited for optimal comfort and support.

A particular objective of the invention is to provide a system and method which determines both pressure distribution and body support requirements for providing mattress systems to individuals based on the particular body characteristics of the individual.

Further objectives of the present invention are to provide a system and method capable of optimizing pressure characteristics of a person on a mattress and capable of taking into account the support characteristics that the mattress provides for the person.

5 The present invention attains the above described objectives, overcomes the drawbacks of known systems of the prior art and fills the needs set forth above.

10 According to the principles of the present invention, data is acquired of the body characteristics of an individual customer. The data preferably includes body dimensions of the person such as, for example, height, torso length, hip width, waist width and shoulder width, as well as the overall weight of the person.

15 Preferably, the data is collected by providing a pressure sensor array on the surface of a standardized support such as an airbed mattress and collecting pressure data over the two-dimensional array. The overall air mattress pressure is also recorded. In the preferred embodiment, the data is processed by a computer which derives the body characteristics of the individual.

20 Further, according to the invention, data is provided that relates each of a plurality of bedding products, that is, mattresses and mattress and box spring combinations, having different design properties with body characteristic profiles of persons for whom the bedding product provides correct support. Preferably, this data is collected by causing each of a plurality of representative people to recline on each of the plurality of bedding products, evaluating and quantizing the support provided for that person, and measuring, using a pressure sensor array, the pressure distribution of the person when properly supported. Data

which rates the support provided for such person by the bedding product as well as data which rates the pressure distribution are tabulated for each combination of bedding product and each body profile.

In one embodiment of the invention, body profiles of each of the representative people used to test the bedding products are classified by having each such person recline on a test device that includes a test pad on the air mattress. The test pad and air mattress system is standardized so that the data is taken under conditions that are the same for each of the prospective customers of a bedding product. Air pressure sensors are connected to the air mattress to provide data of the total air pressure in the mattress, or on various zones of the mattress, when a person is lying on the test device. The test pad includes an orthogonal array of pressure transducers, for example 30 x 30 array of pressure sensors, that measure local pressures exerted between the pad and the body of the person lying on the device.

With the preferred embodiment, a large number of body types are tabulated. A large number of bedding products are also evaluated. These bedding products include unique combinations of box spring, inner spring, and various layers of padding or fill, including, for example, bottom fill and top fill. With combinations made up, for example, of four box springs, seven inner springs, four types of bottom fill and two types of top fill, a total of 168 mattress and box spring combinations are possible. Each combination is evaluated with respect to each of several different body types. The product evaluations may be carried out with each of a representative plurality of physically different test persons lying on each product and data being taken to quantitatively rate each

such product with respect to support and pressure distribution it provides to each such test person. Each test person is also tested on the standardized pad and airbed system and the body type of each such test person is automatically classified by the computer. A table evaluating each bedding product for each
5 body type can be generated.

In the preferred embodiment of the invention, rather than providing data for each of a plurality of body types and for each of a plurality of bedding products, 168 bedding products in the example above, certain body characteristics can be correlated to coefficients for each of the various bedding
10 components. For example, one coefficient can be derived from each body type as primarily affecting selection of the box spring, with another coefficient for inner spring, another for bottom fill and another for top fill. It is found that overall weight most affects the box spring selection, while weight distribution most affects inner spring selection. Various body dimensions affect selection of fills
15 or padding.

According to alternative embodiments of the invention, instead of the customer reclining on a pressure array pad on an air mattress, no pressure pad array is used, but the person is asked to provide certain body characteristic information. In one such alternative embodiment, the person is asked to recline
20 on a standardized airbed and an overall pressure reading is taken. The person answers a limited number of questions. The answers to the questions and the overall pressure reading are correlated by a computer with the mattress that most closely provides the optimal support and minimal pressure to a person most closely matching the body profile. This embodiment is suitable for

providing a customer with the most suitable one of a small number of bedding products, for example four or five products, based on a minimum of questions, such as sex, age, height and whether a person experiences any particular pain. In another such alternative embodiment, no measurements are taken, but only questions are asked of the customer, and the questions are more extensive. Additional questions such as the weight of the person and various clothing sizes of the person are filled out on a questionnaire. This embodiment also is mainly suitable for selecting the best bedding product from among a relatively small number of possible products, for example, four.

The present invention allows a customer to enter a retail mattress store or the like, and purchase a mattress which is customized specifically for that person. The individual will be asked to lie down on an evaluation mattress and/or complete a questionnaire. In the preferred embodiment, where a pressure array pad is used in combination with an air mattress, the pad is positioned atop the standardized evaluation air mattress. The pad includes a plurality of pressure sensors that measure the pressure between the person lying on the mattress and the mattress. The computer scans the pressure data output by the sensors of the pad array and, by scanning the sensors in particular orders and interpreting the sensor outputs, the coordinates of the extremities of the person lying on the mattress are located and body dimensions and other parameters are determined. The pad gathers information from a person lying on the pad, such as the person's height, the person's weight, the distribution of the person's weight or the support pressure value distribution over the various sensors of the array, the area over which the person's weight is distributed, the

width of the person's shoulders, the width of the person's waist area and the width of the person's hips, and the weight born by certain areas of the pad such as that supporting the lumbar area. In particular, data correlated to the lumbar curve of the person's back when in a lying position is derived.

5 From the measured and derived information, the system's computer preferably generates a plurality of coefficients that are most useful for determining one or more mattress system components that provide the best comfort and support for the customer. A decision as to which mattress system design provides the best comfort and support for a person of a particular body
10 type can be made by any of the various theories supported by professionals. The present invention assumes that the appropriate mattress system for a given body type is that which provides the lowest maximum pressure between the person and the upper support surface of the mattress while providing a spinal curvature that is regarded as proper by knowledgeable professionals.

15 In the illustrated embodiment of the invention, four coefficients are derived. These include a coefficient that relates to the box spring, one that relates to the innerspring, and two that relate to mattress fill materials, including one that relates to a bottom fill material which includes padding adjacent the innerspring unit, and one that relates to a top fill material which includes
20 additional the quilted ticking and additional padding that provides the outer covering of the mattress. In determining the coefficients, the computer of the system computes the spinal support required for the individual and certain body weights and dimensions from the pressure pad data. The computer calculates and displays a body contact profile, a spinal support profile, body distribution

profile and other comfort and support factors. A graph showing respiratory effort will be generated from the mattress on which the pad is placed. The coefficients that are generated from the evaluation system correlate to components available for manufacture of a mattress or foundation unit that will be custom built according to each customer's unique body shape and weight or to select an available and compatible mattress and foundation unit from stock.

In the preferred embodiment, body type coefficients are produced and correlated with a table of product design parameters to arrive at the optimum bedding product for the user according to the user's particular body type. The correlation table is preferably generated by a method of determining the support characteristics of each test mattress in a mattress retailer's catalog or inventory relative to the weight and size profiles of a plurality of individual test persons. The method may, for example, include the steps of (a) measuring the weight distribution profiles of numerous different height, weight and shaped test persons; (b) measuring and determining the optional deflection profile of those same persons for optimal support; (c) inputting the information of steps (a) and (b) into a computerized control; (d) locating a selected mattress in a test apparatus; (e) applying a weight profile load of selected test profile persons to pistons connected to independently movable pressure plates of the test apparatus, which pressure plates are positioned and sized on the mattress so as to mimic the shape of the selected persons; (f) measuring the deflection of each pressure plate into the test mattress; and (g) comparing the measured deflection characteristics of the test mattress to the optional support deflections for the test profile persons. Alternatively, the table may be generated by a

method of determining the support characteristics of each test mattress relative to human weight and size test person profiles by (a) measuring the weight distribution profile of numerous different height, weight and shaped test persons; (b) measuring and determining the optional deflection profile of those same persons for optimal support; (c) inputting the information of (a) and (b) into a computerized control; (d) locating a selected mattress in a test apparatus; (e) applying optimum deflection characteristics profile of a selected test profile person to that mattress by applying pressure to pistons connected to independently movable pressure plates of test apparatus, which pressure plates are positioned and sized so as to mimic the shape of the selected test profile person; and (f) measuring the pressure on the pistons to obtain this optimum deflection.

Brief Description of the Drawings

The objectives and features of the invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of the system according to a presently preferred embodiment of this invention; and

Fig. 2 is a representative display of pressure profile information generated and utilized in this invention.

Fig. 3 is a perspective view of a mattress product rating subsystem for use with the system of **Fig. 1**.

Fig. 4 is a cross-sectional view of the subsystem of **Fig. 3**.

Figs. 5 and 6 are diagrams of the operation logic of the mattress product rating subsystem of **Figs. 3 and 4**.

Detailed Description of the Invention

Fig. 1 schematically shows a customized mattress providing system 10 according to one embodiment of the present invention. The system 10 is a customized mattress evaluation, selection or designing system and includes an automated body type determination subsystem 25 by which data characteristic of a person's body shape or body type is generated. The system 10 also includes a bedding product rating data source or subsystem 26 and a mattress selection or designing subsystem 27. The mattress selection or designing subsystem 27 includes a manual or automated system by which mattress product design information from the bedding product rating data source 26 is correlated with specific body type information from the system 25 for an individual bedding customer to arrive at a design for a mattress produce that has been custom designed or selected for that customer.

The body type determination subsystem 25 includes a support surface 12 which may be typically located in a retail mattress store. The support surface 12 is preferably an air bed or some other structure that can be assured of producing standardized support characteristics that are consistent over time. Such an air bed may typically have a plurality of sealed zones, typically four in number, with a specified and constant amount of pressure in each. Pressure of the air bed zones is typically at or near twelve inches of water pressure in an unloaded state. The subsystem 25 further includes a pressure sensor array pad 14, which is positioned on the top of the support surface 12. The pad 14 includes an array

of pressure sensors 30, of for example 900 or 1,024 in number. Preferably the array is rectangular with the sensors 30 arranged in a plurality of orthogonal columns and rows. The sensors 30 are calibrated to each produce a zero output when no person is reclining on the pad, but to each produce an output signal proportional to the pressure exerted on an area of the pad at which the sensor is located

In use, a person 16, for example an individual bedding customer, lies on the pad 14 while it is positioned on top of the support surface 12. Pressure on each of the individual pressure sensors 30 of the pad 14 is measured by the sensors 30 and a pressure signal containing pressure profile array data 18 is generated. Optionally, pressure sensors (not shown) in the zones of the airbed support 12 may also generate signals of support pressure data 31 of each of the airbed zones. The signals 18 and 31 are relayed to a computer 32 or other processor which records digital information of the pressure profile 18, and pressure data 31 if used, of the person 16 lying on the support surface 12.

The computer 32 derives information from the digital information records by processing the data. The information which can be derived from the pressure data includes, for example, that of the person's height, weight, distribution of weight, width of shoulders, width of waist area, width of hips and the lumbar curve of the person's back when in the lying position. The pad 14, along with the sensors 30 and the software or algorithm for generating the pressure profile is commercially available from Vista Medical of 120 Maryland Street, Winnipeg Manitoba, Canada. The Vista Medical Force Sensing Array: Pressure Mapping System is described by its manufacturer as a clinical tool used to assess

pressure distribution and positioning. The information from the force sensing array pad or mat is displayed on a computer screen as easy to understand color graphics and data, a sample 60 of which is shown as **Fig. 2**, with different colors codes 61 used to illustrate different pressure readings. Numerous display options of the system may include a table 62 of numerical pressure values and statistical data, and three-dimensional wire-grid representation 63 of the pressure distributed over the array of the pad 14.

The pressure profile data generated for the individual person is then used, in a preferred embodiment, to generate specific body shape coefficients or other body type parameters 33 which define mattress design parameters. In a presently preferred embodiment, the mattress design parameters include a box spring coefficient, an innerspring coefficient, a bottom fill coefficient and an upper fill coefficient. The program in the computer 32 which generates these mattress design parameters in a presently preferred embodiment is written the Microsoft VISUAL BASIC computer language, a source code of which is set forth in Appendix A to this application.

In particular, the program in computer 32 reads in the data from the sensors 30 by scanning the outputs of each of the sensors of the rows and columns of the array of the pad 14 with a user reclining on the pad. In the program set forth in Appendix A, note that the rows are defined as being parallel to the body of the user 16 while the columns are defined as transverse to the body of the user 16. First, the output of each of the sensors 30 of the array is tested against a minimum threshold to determine the area of the pad that is supporting the weight of the user. This area is represented by the number of

sensors having a reading above the threshold. Second, the pressure outputs of each of the sensors 30 are summed and from this sum the weight of the user is calculated. Third, the weight of the user is divided by the number of sensors supporting the user to arrive at an average pressure per unit area or weight distribution.

Next, the outputs of the sensors are scanned from the ends of the rows to locate the extreme head and foot positions of the user on the pad. From these head and foot positions, the height of the user is calculated. The crotch height of the user is also calculated from the head and foot positions, using statistically averages body proportions. Then, from the head and foot positions, a calculation is made of the user's shoulder height, using statistically average body proportions, and at this height the shoulder positions of the user are determined by scanning sensor outputs from opposite ends of the columns at this shoulder height, and from the shoulder positions the user's shoulder width is calculated. In addition, positions of the shoulders, such as the top of the shoulders, the center of the shoulders and the center of the hips can be determined by scanning the sensor outputs and computing intermediate positions. Such additional determinations are optional, and may be used to determine the position of the user on the pad and to make corrections in the event that the user is not reclining on the center of the pad.

Further, lumber support is determined. This determination uses the crotch height and waist center calculations to define a rectangular area of the pad that is supporting the lumbar portion of the users back. The total pressure readings of the sensors 30 over this lumbar area is calculated and this total

lumbar force is divided by the average pressure calculation of the entire user support area to produce a lumbar curve coefficient. This area provides information that can be correlated with empirical data from which correlation the lumbar curve of the user can be determined.

5 From the above measurements and calculations, four coefficients are derived which define the body type parameters that serve as the mattress design parameters discussed above. One is a box spring coefficient which is directly proportional to the total calculated weight of the user. Another is the innerspring coefficient which is proportional to the total weight of the user divided by the
10 average pressure on the sensors 30 in the support are of the pad 14, which is proportional to the area of support or total number of sensors measuring pressure. Additionally, a bottom fill coefficient is calculated by dividing the total weight of the user by the user's shoulder width and a top fill coefficient is set as directly proportional to the lumbar curve coefficient. All of the coefficients are
15 multiplied by constants.

 The specific mattress design parameters or above-identified co-efficients are used to specially make a mattress or mattress and box spring combination optimally compatible with the individual customer. Alternatively, based upon the mattress design parameters or co-efficients, a specific mattress available from
20 stock which closely approximates or satisfies the mattress design parameters or co-efficients is selected for the individual. The designing or selection of a mattress may be carried out manually or automatically by correlating the body type or shape parameter data 33 generated by the subsystem 25 from the individual customer with product vs. body type correlation data 34.

The body type correlation data 34 is preferably produced by the manufacturer of the system 10 with bedding product rating data source or subsystem 26 by evaluating various bedding products of a bedding manufacturer and producing a table that correlates various body types, defined by unique combinations of body type coefficients, with support characteristics of the different bedding products. Preferably, the correlation data is generated by generating body type parameter data 48 from a plurality of test persons using a subsystem 25a that is identical to the body type determination system 25 described above. The same test persons or a simulation thereof are then caused to subject the same supporting pressure distribution or support deflection to bedding products having different combinations of the components of box spring, inner spring, top fill and bottom fill. The suitability of each product for supporting the loads of each test person are then evaluated by a professional evaluation system 49, which can be under the guidance of medical professionals. A computer 50 may then be used to correlate the data 48 of the body types of each test person with the rating data 49 of the various bedding products. The mattress design or selection subsystem 35 matches the body type parameter data 35 from the individual customer with the bedding product vs. body type correlation data 34 to arrive at a customized mattress design 22.

A system for assessing the specific deflection characteristics of a mattress can be utilized to determine which specific mattress design is appropriate to satisfy the mattress design parameters. Such a mattress design system is envisioned to include a machine 70, as illustrated in **Figs. 3 and 4**, which has a plurality of spaced platens 71 arranged over the upper surface of

selected mattress product 72. The machine 70 can be controlled to simulate each of the test persons who 46 so that the deflection characteristics of each mattress product with respect to each of the platens 71 can be measured as the platens are depressed downwardly into the mattress to determine the force versus deflection data for the particular mattress. Optimally, the multiple platens are arranged in the shape of a human body with forces in proportion to the human body and physique of each of the test persons. The deflection is controlled to be optimal from a support or optimal lumbar curve standpoint. In this way, each bedding product is rated for suitability for the support of persons having each of the body types defined by the body type parameters that the test persons produced. For each test person and bedding product, the ratings of the various products seeks to minimize support pressure, as measured by a pad 14 between the mattress 72 and the platens 71, while optimizing the lumbar curve of the test person on the product. A VISUAL BASIC computer program for controlling the machine 70 is set forth in Appendix B to this application.

The machine 70 is a piece of testing equipment designed to optimize the performance of mattresses or other bedding products for particular body types or styles defined by use of the subsystem 25. This machine 70 can measure either mattress deflection based on a predetermined pressure load or pressure based on a predetermined mattress deflection. Each of the platens 71 is driven by a pressure piston so as to mimic the shape of a portion of the human body. The pressure plates or platens 71 are strategically placed and shaped so replicate the shape of a human body when placed on a mattress or other bedding product, and are driven by piston pressure to replicate the body type

characteristics of various test persons. The bedding product is rated for pressure distribution and support by placing it on the testing table and activating the pressure pistons to move the pressure plates downwardly into contact a pressure array pad 14 on the top surface of the bedding product being rated.

5 Computer 48 provides input to the pressure pistons so that the pressure plates apply pressure to the bedding product in a desired pattern so as to mimic a specific body type lying on the bedding product. These inputs are varied to rate the reactions of different types of bedding products with different pressure patterns representative of different body types. The deflection of the individual
10 springs reacting to a predetermined load or configuration of load are used to rate mattresses which have a desired set of deflection characteristics when a predetermined pressure pattern is placed on the bedding product. The ratings particularly take into account lumbar support or production of the optimal lumbar curve as well as a minimization of the maximum support pressure between the
15 user and the mattress.

Additionally, the testing apparatus may determine which type of individual is best suited for a particular construction of bedding product. In this testing mode, the pressure pistons are moved a fixed distance into the bedding product corresponding to the distance a particular type of person would move the springs
20 of the bedding product. A computer then reads the pressure on each of the pressure pistons. This information can be used to manufacture bedding products which have desired deflection characteristics at certain places on the bedding product.

1771 1772 1773 1774 1775 1776 1777 1778 1779 1780 1781 1782 1783 1784 1785 1786 1787 1788 1789 1790 1791 1792 1793 1794 1795 1796 1797 1798 1799 1800 1801 1802 1803 1804 1805 1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823 1824 1825 1826 1827 1828 1829 1830 1831 1832 1833 1834 1835 1836 1837 1838 1839 1840 1841 1842 1843 1844 1845 1846 1847 1848 1849 1850 1851 1852 1853 1854 1855 1856 1857 1858 1859 1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2